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THESIS

**A PERIODIC REVIEW INVENTORY POLICY FOR
SMALL MILITARY HOSPITALS**

by

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December 2000

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**A PERIODIC REVIEW INVENTORY POLICY FOR SMALL MILITARY
HOSPITALS**

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Submitted in partial fulfillment of the
requirements for the degree of

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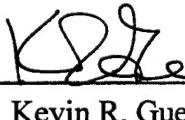
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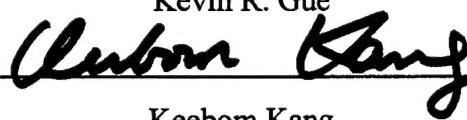


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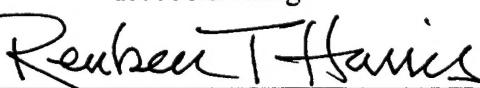
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ABSTRACT

We report on potential transportation, administrative, and inventory savings through an extended partnership between military hospitals and commercial prime vendors. We develop a simulated (Q,r) inventory model that incorporates inventory management concepts of optimal reorder points and quantities, and then compare the results to a periodic order policy. We compare the policies with a simulation that considers the effects of integrating inventory management, shipping, and invoice processing with the Prime Vendor. Our results suggest that small military hospital may benefit from a periodic review inventory policy.

TABLE OF CONTENTS

I. INTRODUCTION.....	1
A. BACKGROUND	1
B. PURPOSE.....	3
C. METHODOLOGY	3
D. SCOPE	4
E. ORGANIZATION	5
II. PRIME VENDOR PROGRAM	7
A. MEDICAL LOGISTICS PRIOR TO PRIME VENDOR.....	7
B. PRIME VENDOR OVERVIEW	10
1. Distribution and Pricing Agreements.....	11
2. Ordering Procedures.....	12
3. Receiving Procedures.....	13
4. Stockless Option.....	14
5. Defense Medical Logistics Standard Support.....	14
C. INVENTORY AND ORDERING PROCEDURES WITHIN THE MEDICAL TREATMENT FACILITY	15
1. Micro-MICS Problem Areas	16
D. DOD VENDOR MANAGED INVENTORIES	18
E. COMMERCIAL VENDOR MANAGED INVENTORIES	18
III. SIMULATION MODEL	21
A. OVERVIEW	21
B. (Q,R) METHODOLOGY	21
1. (Q,r) Analysis	22
2. (Q,r) Inventory Simulation	23
3. (Q,r) Simulation Results.....	25
C. SIMULATION MODIFICATION FOR PERIODIC ORDER POLICY.....	26
1. Simulation Modification.....	26
2. Simulation Modification Results	29
D. ANALYSIS	30
1. Percentage Change in Order Days.....	31
2. Percent Change in Annual Holding and Ordering Cost.....	32
E. TOTAL ESTIMATED SAVINGS	32
IV. CONCLUSIONS AND RECOMMENDATIONS	35
A. SUMMARY	35
B. CONCLUDING COMMENTS	35
C. AREAS FOR FUTHER RESEARCH	36
1. Consignment.....	36
2. Training of Medical Logistics Personnel.....	37
APPENDIX A: PRIME VENDOR INVOICES	39
APPENDIX B: (Q,R) SPREADSHEET RESULTS	51
APPENDIX C: SIMULATION RESULTS.....	53
LIST OF REFERENCES.....	59
INITIAL DISTRIBUTION LIST	61

LIST OF FIGURES

FIGURE 1 SAN FRANCISCO PRIME VENDOR REGION11

x

LIST OF TABLES

TABLE 1 UNIFORM MATERIAL MOVEMENT AND ISSUE PRIORITY SYSTEM (FROM DMMONLINE).....	9
TABLE 2 (Q,R) RESULTS.....	23
TABLE 3 (Q,R) MONTE CARLO SIMULATION FOR ITEM 1	25
TABLE 4 INVENTORY RESULTS FROM THE (Q,R) SIMULATION.....	26
TABLE 5 PERIODIC REVIEW MONTE CARLO SIMULATION FOR ITEM 1	28
TABLE 6 INVENTORY COSTS FOR THE PERIODIC ORDER POLICY SIMULATION.....	29
TABLE 7 ESTIMATED ANNUAL SAVINGS FOR 28 SMALL NAVAL HOSPITALS	33

I. INTRODUCTION

A. BACKGROUND

In May 1990, the Under Secretary of Defense for Acquisition established an inventory reduction plan to pursue alternatives to current material storage programs. The plan stated, "Where Department of Defense (DOD) requirements can be met through commercial distribution systems in a timely and cost effective fashion, no value is added by pushing items through the DOD warehousing system"¹.

In 1991, the General Accounting Office (GAO) compared commercial medical logistics practices with similar DOD operations². At the time of the report, DOD supported 125 medical centers in the continental United States. These facilities procured approximately \$1 billion in consumable medical supplies. The DOD maintained 443 warehouses and 17 depot warehouses to manage \$824 million of inventory to support daily medical operations. Medical warehouses held inventory that would last 95 days, and the Defense Logistics Agency (DLA) stored 250 days of inventory in the depots. The GAO report recommended that the DLA use prime vendors to deliver supplies from a variety of manufacturers directly to medical facilities, resulting in the first medical and surgical prime vendor contract being awarded in June 1993.

¹ USD Acquisition, 10-point Inventory Reduction Program, May 1990

² GAO/NSIAD-92, DOD Medical Inventory, Reductions Can Be Made Through the Use of Commercial Practices.

The Prime Vendor program is the result of the Defense Supply Center, Philadelphia's (DSCP) commitment to reengineering efforts within medical logistics through partnership with commercial vendors and military hospitals. The program began in order to reduce the inventory within DLA warehouses, which were stocked with millions of dollars of material. The overall purpose of the prime vendor program is to shorten the logistics pipeline, eliminating the layering of supplies at multiple echelons, shifting the inventory, inventory management, transportation, and personnel costs from the Government to commercial vendors. The prime vendor program takes advantage of the experience of these commercial vendors, whose profit-based business practices demand lean inventories and rapid deliveries. Prime vendor initiatives have typically allowed the DOD to achieve significant annual savings and revolutionize logistics support of the retail customer³.

Prime vendor contracts are not negotiated by individual military hospitals, but are awarded by the Naval Medical Logistics Command. These prime vendor contracts are written to provide for daily ordering and replenishment. The structure of the contracts is the same for all hospitals, but the contracts affect large and small hospitals differently.

For example,

1. Small military hospitals do not order the same high volume; therefore, daily orders are small, requiring more costly transportation.

³ Office of the Secretary of Defense, Tricare

2. Small military hospitals are typically not located in large metropolitan areas and do not have the same immediate access to replenishment, creating the possibility of increased shipping costs per order.

B. PURPOSE

Our purpose is to determine whether the inventory policy of daily order processing, dictated through the use of generic prime vendor contracts, is appropriate for all hospitals. We define and test with simulation two inventory processes; a (Q,r) inventory policy and a periodic review inventory policy. These two simulations provide the military hospital with costs associated with invoice processing, ordering and holding inventory, and transportation.

C. METHODOLOGY

We gathered all prime vendor invoices over a six-month period from the Naval Hospital Lemoore, CA. We also retrieved the monthly reports from the hospital inventory management system, Micro-Medical Inventory Control System, and compared the invoice with receipts in the inventory system. All items ordered from the prime vendor for the time period were entered into an Excel spreadsheet for analysis.

We group all items by national stock number and prime vendor order number to determine annual demand for each item, total annual cost for each item, and average size of each order. The annual demand, item cost, and inventory order and carrying costs are used to develop the optimal order quantity Q^* and reorder point r^* . We use the optimal

order quantity Q^* and reorder point r^* to build a base simulation model that details the daily inventories and reorder days to satisfy the annual demand. Next, we compare results of this simulation are then compared to the actual data that was gathered at the military hospital. Finally, we build a periodic order simulation in an attempt to achieve greater efficiencies in the areas of transportation, inventory, and invoice processing. .

D. SCOPE

We address the issues of shipping, inventory management, and invoice processing. There is a personnel cost associated with inventory management in military hospitals, but it is not part of our study of achievable efficiencies with the prime vendor. We believe that personnel management in the military hospital is a large topic that deserves a separate study.

We address only medical supply items currently procured through the prime vendor. The prime vendor contract is considered a requirements contract, meaning that the military hospital is required by law to procure medical items offered by the prime vendor through the prime vendor in its region. We assume that all medical items that are routinely used by the military hospital are procured through the prime vendor. We do not consider medical items not procured through the prime vendor, because they are not considered regular or high volume items.

We categorize as a small hospital any Navy facility that procures less than \$150,000 per year through the prime vendor program. Using this criterion, the Navy operates 28 small and 17 large hospitals.

E. ORGANIZATION

We have provided the reader with the background, purpose, methodology, and scope of our thesis. Chapter II discusses the prime vendor program. Chapter III introduces the simulation models with comparison and analysis. Finally, Chapter IV presents conclusions and recommendations.

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II. PRIME VENDOR PROGRAM

A. MEDICAL LOGISTICS PRIOR TO PRIME VENDOR

Prior to the Medical Prime Vendor Program, logistics costs consumed approximately 43% of a Medical Treatment Facility's budget⁴. Supply procurement and delivery times were greater than 60 days and average on-hand inventories were equal to more than 6 months of a hospital's material requirements. The main source of medical supply was the Defense Logistic Agency's (DLA) depot Defense Supply Center Philadelphia (DSCP). Medical supply items were procured through DLA's depot with minimum required delivery times following the Uniform Material Movement and Issue Priority System (UMMIPS).

UMMIPS is used throughout the federal government to identify the relative importance of competing demands for material and other logistics system resources. It provides a standard method of assigning a priority to a requisition for an item, based on military importance and urgency of need. The priority determines the order in which a backorder is released, the time frames for processing the requisition, and prompts the item manager to take specific fill, backorder, or cancellation actions. UMMIPS is used to identify the relative importance of demands, not only for the material, but also for its processing and transportation. Under UMMIPS, urgent requirements are given priority over requisitions for housekeeping and administrative supplies, or similar requirements.

⁴ Office of the Secretary of Defense, Tricare: Prime Vendor Program Division

Therefore, UMMIPS gives recognition and preferential treatment to material needs, the lack of which will prevent or seriously impair a command's ability to carry out its assigned mission. UMMIPS provides three possible Urgency of Need Designators (UND) listed Table 1.

All requisitions processed through depot system are assigned a Force/Activity Designator (FAD) I - V, limiting the requisitioner to choosing from three Priority Designators consistent with the UND. For example, a requisitioner assigned FAD III normally selects Priority designator 03, 06, or 13 based on the requisitioner's determination as to whether his UND is A, B or C. UMMIPS also affects transportation of the requested items. If the items requested are FAD II - UND C, when they arrive at an Air Mobility Command (AMC) terminal awaiting transportation, they are placed on available aircraft according the UMMIPS categories. When medical items reach the AMC tarmac they are competing for space with all items in need of transportation. In reality the time that it takes from order to receipt of an item exceeds those times indicated in the UMMIPS table. Due to slow turnaround times at the depots, military hospitals were forced to keep large inventories of consumable items.

		URGENCY OF NEED DESIGNATOR*		
		Unable to Perform Mission	Impaired Operational Capability	Routine
Force/Activity Designators		A	B	C
I	SECDEF/JCS Designated Units	01	04	11
II	Deployed to/Operating from OCONUS; CONUS 90 days prior to deploying	02	05	12
III	OCONUS not in FAD II; CONUS deploying prior to D+30	03	06	13
IV	Other Activity & Selected Reserve Forces	07	09	14
V	All Other	08	10	15

Table 1 Uniform Material Movement and Issue Priority System (From DMMOnline)

Medical items available in the DLA Depots are published in the Federal Supply Schedule (FSS). The prices of these items are set through the competitive bid process, which results in low prices paid to the commercial distributor. DLA then adds a surcharge as high as 55% to cover operating costs. The price plus surcharge increases the actual price paid for items by the military hospital above the price charged by a civilian distributor, including the cost of transportation. Taking into account the 60-day lead-time and the elevated price of consumable medical supplies, the military hospital often bypassed the depot supply system in order to meet their demand for medical supplies in

an expedient and cost effective manner. The high variability of orders from the military hospital through the depot supply system resulted in additional inventory carrying costs that were passed onto the customer as increased surcharges.

A 1992 GAO study states that "DOD buys and stores large inventories to ensure that it has medical supplies when needed. DOD medical facilities often store quantities of the same medical supplies on (in storerooms) their wards, in basement storerooms, and in 443 separate warehouses in the continental United States". The results of the report said "DOD's health care system can save millions of dollars by increased use of inventory management practices pioneered by leading civilian hospitals". This report led to the implementation of best commercial practices and the Prime Vendor Program for medical supplies.

B. PRIME VENDOR OVERVIEW

The prime vendor program has reduced product procurement and delivery lead times from 45 days to 2 days or less and on-hand inventories at Medical Treatment Facilities have decreased by up to 85%. The overall goal is to decrease the costs of holding inventory, procurement and shipping, and administration. The future of medical logistics reengineering efforts decreases the amount of time and effort spent on the order and replenishment process with the objective of decreasing the non-prime vendor purchases to 5% or less of the total amount of purchases in the military hospital.

In the prime vendor program a single commercial distributor/supplier serves as the primary provider of product to various federal customers within a geographical region

or zone. The San Francisco prime vendor region, shown in Figure 1, illustrates the area covered by the contract awarded to Owens & Minor Medical. All three service branches are represented in the area, squares are Air Force medical facilities, circles are Army medical facilities, and triangles are the medical facilities for the Navy.

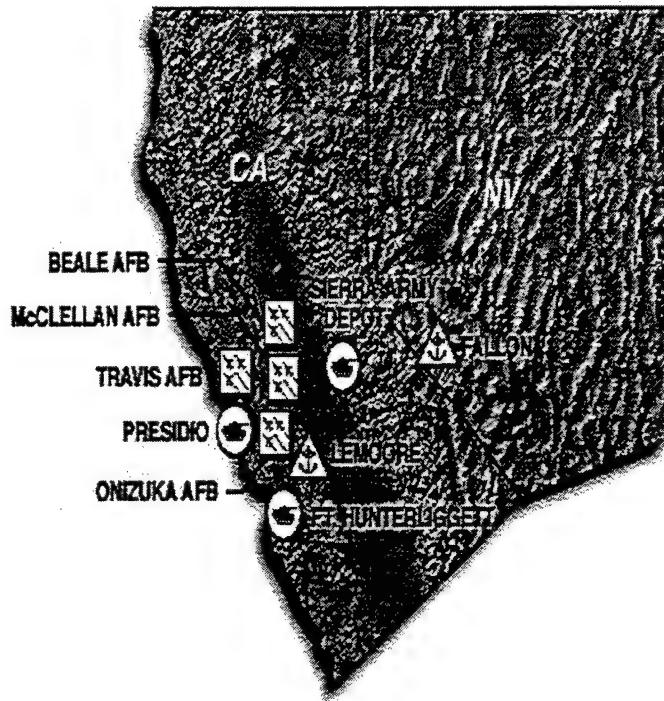


Figure 1 San Francisco Prime Vendor Region

1. Distribution and Pricing Agreements

Pricing of medical items ordered through the prime vendor program is determined by Distribution and Pricing Agreements (DAPA). A DAPA is an agreement negotiated between the manufacturer of the medical item and the government. The DAPA sets the

price for the item, but does not guarantee any amount of sales. An item must have an established DAPA before it can be purchased through the prime vendor.

Prime vendors are expected to establish business relationships with all medical supply manufacturers that have an established DAPA. These business relationships must be consistent with the prime vendor's commercial business practices. Distribution charges incurred by the prime vendor are negotiated during the contract award procedure with the government and set as a percentage of the published DAPA price. The DSCP then adds an administrative fee, which is also set as a percentage of the DAPA price. The delivered price, original DAPA price plus the distribution and administrative fees, is the only price that is visible to the ordering military hospital. If an item had an original DAPA price of \$20.00, a distribution fee of 5%, and an administrative fee of 1%, the resulting price paid by the military hospital would be \$21.21 for each item.

2. Ordering Procedures

The prime vendor makes either routine or emergency deliveries to the medical treatment facility. Routine deliveries are categorized as Just-In-Time Orders (JITO) and Extended Delivery Orders (EDO).

- Emergency Orders: The prime vendor provides access to emergency orders 24 hours a day, 7 days a week. Up to two emergency orders are processed per month at no charge to the military hospital. The ordering facility is charged applicable transportation and handling costs for all subsequent emergency orders. Emergency orders are required to be shipped by the fastest possible carrier.

- Just-In-Time Orders: Orders that the military hospital wants to be delivered within 24 hours. For an item to be delivered as a JITD order, the medical facility must provide monthly usage data on the item. The prime vendor stocks JITD items in their warehouse based on the usage data provided. This is the primary order type for high use items.
- Extended Delivery Orders: Orders for items that do not have usage data assigned from the military hospital are placed as EDO's. Items without usage data assigned, because they are not routinely ordered by the military hospital, are not stocked in the prime vendor warehouse. When an EDO order is received, the prime vendor places an order to the manufacturer. An EDO is to be shipped to the military hospital within 7-10 business days.

The ordering military hospital can identify any DAPA item that they submit usage data on as a JITD item. The prime vendor is then required to stock and ship the item within 24 hours. Just-In-Time and Extended Delivery orders must be processed on separate purchase orders, resulting in multiple orders processed on the same day.

3. Receiving Procedures

After receiving and inspecting a prime vendor order, the military hospital reserves funds in their financial system necessary to cover the cost of the order. The prime vendor also sends an invoice to the Defense Logistics Agency (DLA) for payment. After the DLA matches the prime vendor invoice with the funds reserved at the medical facility, it

issues payment to the prime vendor. The DLA then removes the necessary funds from the military hospital's financial system.

4. Stockless Option

The stockless option of the prime vendor program is only available in the National Capital Region in Washington, D.C. and Lone Star Region of Texas. With the Stockless Option, the prime vendor is contracted to resupply the hospital directly through individual department storerooms within the facility. The prime vendor monitors inventory in each department and issues resupply items needed, bypassing the hospital warehouse entirely. The cost for this program is an additional service fee added to the visible DAPA price. In the National Capital region the Stockless Option adds 11% and in the Lone Star region it adds 7.4%. Using this option is at the discretion of the military hospitals that reside in the available region.

5. Defense Medical Logistics Standard Support

The deployment of the prime vendor program revealed problems associated with outdated inventory management systems. Prime vendors are awarded contracts for a region, not a selective branch of the service. Each service had its own inventory management systems in its hospitals, resulting in up to three different requirements for the prime vendor. Also, it was difficult for DSCP to gather and interpret data from many different inventory management systems. The DLA is standardizing these different inventory management systems by deploying the Defense Medical Logistics Standard

Support system (DMLSS), which is designed to reduce the time health care professionals spend on logistics activities, and improve the effectiveness and efficiency of health care delivery. The standardized automated information system will replace current DOD legacy systems such as the Navy's Micro Medical Inventory Control System (Micro-MICS), the standard inventory management and control software currently used by Navy hospitals.

The DMLSS program is being deployed in modules. The first and current module in operation is called Forward Customer Support (FCS). It gives customers computers to initiate supply orders electronically and provides one stop shopping and the ability to research and compare products and prices using common or brand names. It groups similar (or equal) medical and surgical items and can perform unit of measure price comparisons. FCS can also initiate product order requests. Rather than typing a procurement requisition, FCS will either print a supply requisition or electronically process the request. DMLSS is intended to enhance operations by automating manual processes, improving processes already automated, and eliminating existing processes that add no value.

C. INVENTORY AND ORDERING PROCEDURES WITHIN THE MEDICAL TREATMENT FACILITY

The Naval Hospital Lemoore uses the Microcomputer Medical Inventory Control System (Micro-MICS) to track inventories within the warehouse. Micro-MICS is a complete inventory system that tracks outstanding orders, receives and issues items, and

details daily on-hand balances. Micro-Mics can be interfaced with the DMLSS server in order to send information between the two systems and allow customers to see beginning daily inventories within the hospital warehouse. The customers also have the ability to place orders for items located in the warehouse using the Forward Customer Support (FCS) module of DMLSS. Customer orders processed through FCS are placed on the DMLSS server until the DMLSS administrator transfers the orders to the Micro-MICS server. Once the orders are transferred, they can be processed and Material Release Orders (MRO) issued to the warehouse for pulling and delivery.

Inventory within the hospital warehouse is managed manually. When an item is in need of replenishment an order is given to the Prime Vendor ordering officer for processing. Requests for replenishment of the warehouse are not necessarily processed on the same day that they are received. If warehouse personnel place multiple orders on the same day or if the orders are not processed on a daily basis, there is the possibility of multiple orders being placed with the prime vendor in a single day, resulting in multiple invoices. Note also that when orders are placed through the prime vendor, the contract states that JIT and EDO orders must be processed separately because of the separate contracted delivery times. This increases the probability that multiple orders would be processed per day.

1. Micro-MICS Problem Areas

Micro-MICS is a system that was developed many years before the implementation of the prime vendor program. Micro-MICS cannot track inventory of the

same item with multiple prices. The price charged to internal customers is the price of the last item received. That means that an item that is stocked at a level of 1000 at a price of \$2.00 each has a total value of \$2,000.00. If the next order of 100 items received is priced at \$1.80, then the entire value of the inventory for that item is decreased to \$1,980.

Items entered into the Micro-MICS system must have a National Stock Number (NSN). This is a 13-digit number that is centrally assigned for all items that meet a standard generic description. Problems began when military hospitals began to procure consumable items outside of the depot system. In the depot system items were ordered by NSN, received by NSN, and issued by NSN. Now that items are procured through a commercial vendor, they are not ordered by NSN, but need to be received in the inventory system by NSN. This creates the problem of cross checking prime vendor order numbers with all available NSN's for a match and then entering the items into Micro-MICS. The difficulty arises when the prime vendor changes manufacturers, but the item still has the same generic part number. In the depot system, the manufacturer can change, but the part number remains the same. Now the part has a different prime vendor order number and possibly a different price, but it has the same NSN. Many times an item ordered through the prime vendor does not have a matching NSN. In this case the prime vendor ordering officer assigns a locally generated NSN, which are not standard making it difficult to compare inventory with other military hospitals.

D. DOD VENDOR MANAGED INVENTORIES

The current Vendor Managed Inventory (VMI) initiative within the DOD Medical Department focuses on partnering with commercial healthcare distributors to provide inventory management and guaranteed availability of medical readiness items. Today we have a VMI contract covering pharmaceutical items. The contract uses peacetime dollars to underwrite the distributors' increased safety level expenses. This is necessary to guarantee access to shelf-life material for units deploying during a contingency operation. The VMI program provides a necessary component of DSCP's readiness plan by providing surge and sustainment material until commercial manufacturers can meet increased demands.

E. COMMERCIAL VENDOR MANAGED INVENTORIES

VMI is a version of demand-driven supply-chain management that seeks to eliminate the costs associated with ordering and stocking supplies by understanding and responding to actual daily demands and needs of the customer. This concept of VMI within the commercial industry is not new. Most of the programs are very similar: the customer reports his stock status periodically and the vendor decides if, when, and how much to restock.

Under the current prime vendor program, the prime vendor is contractually obligated to ship all JITO's within 24 hours of receipt or order, regardless of the fact that there may have been a shipment the previous day. The military hospital typically submits requisitions to the prime vendor based on their current inventory levels without using any

forecasting techniques. In this situation, without the prime vendor knowing the actual inventory on hand at the military hospital and actual daily usage, it is more difficult for the prime vendor to offer efficiency suggestions.

Under a traditional VMI system, the military hospital would transmit end of day inventories to the vendor. The vendor then has the autonomy of shipping supplies when they have determined it is most economical. Many customers are not comfortable with the loss of control associated with traditional VMI.

Consignment is a form of VMI where a supplier places goods at a customer location without receiving payment until after the goods are used or sold. Under consignment, it makes no difference to the customer whether a distributor places supplies at a customer's warehouse for two weeks or two years. The amount of inventory the distributor stocks in order to meet delivery times must take into account fluctuations in demand from the customer. In other words they must keep safety stock, which increases annual inventory carrying costs from an industry average that ranges from 20 - 36%. Under consignment the vendor is actually passing on part of their carrying costs to the customer. The vendor has transferred partial cost of the storage, material handling, and inventory loss to the customer, potentially decreasing their inventory carrying costs from 36 to 18%, a reduction of 50%⁵.

⁵ Hospital Material Management Quarterly, May 2000

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III. SIMULATION MODEL

A. OVERVIEW

Our simulation is based on actual annual demand for prime vendor medical items from the Naval Hospital in Lemoore, CA, shipping cost information from the regional prime vendor, Owens & Minor Medical, and prime vendor contract information from the Naval Medical Logistics Command. We build two Monte Carlo simulations that enable us to compare costs associated with ordering and holding inventory, administrative processes, and transportation. Our first simulation uses a (Q,r) inventory policy that is based on actual annual demand and costs. Our second simulation analyzes a fixed period, variable reorder quantity inventory policy.

B. (Q,r) METHODOLOGY

We visited the Naval Hospital Lemoore and gathered all prime vendor invoices for a six-month period (see Appendix A). We selected 10 items from the data that had high average daily demand during the six months and built a (Q,r) model to compute the order Quantity Q^* and the reorder point r^* . We use the results of the (Q,r) analysis to simulate the daily inventory with replenishment and receipt days. We compare these results with the actual number of order days experienced by the Naval hospital. In our second simulation we examine the inventory level periodically (every seven days) and place an order if the inventory is at or projected to fall below the reorder point r^* prior to the next review date.

1. (Q,r) Analysis

The (Q,r) analysis for all items uses a fixed order cost A of \$2, a holding rate h of 30% per year, where h_i is equal to 30% multiplied by the cost/unit C_i , and a cost of a short C_s equal to \$50, a typical overnight shipping cost for an average size box. The order cost A is determined from observing and speaking with the prime vendor ordering officer at Naval Hospital Lemoore. The average wage grade for a prime vendor ordering officer is General Schedule 7 (GS-7) at \$14 per hour. The ordering officer at Naval Hospital Lemoore spends an average of 10 minutes on a prime vendor order resulting in an order cost of \$2. Because the invoice processing cost is not visible to the military hospital, we do not consider it as an order cost in our model.

We derive the optimal reorder quantity Q_i from the economic order quantity (EOQ) formula⁶. We determine the reorder point r_i by calculating the service level SL where $SL = C_s / C_s + C_e$ and $C_e = h_i(Q_i/D_i)$. Given the short leadtime L , relatively small unit cost C_i , and large proportionate cost of a short C_s , the service level SL for each item in our sample set is greater than 99%. The reorder point is $r_i = L(D_i/365) + Z_{SL}\sigma_i$, where Z_{SL} comes from the standard normal table, and σ_i is the standard deviation of LTD . Table 2 lists the Q^* and r^* values for each of the 10 items.

⁶ Adelman, Barnes-Schuster, Eisenstein 1998

	Item									
	1	2	3	4	5	6	7	8	9	10
Annual Demand	3096	288	912	640	680	1060	14000	2640	276	140
Cost/Unit	\$0.42	\$6.46	\$0.82	\$1.13	\$5.31	\$5.31	\$0.11	\$0.88	\$12.48	\$18.07
Leadtime Demand	25.4	2.4	7.5	5.3	5.6	8.7	115.1	21.7	2.3	1.2
Standard Deviation	5	1.5	2.7	2.3	2.4	3	10.7	4.7	1.5	1.1
Reorder Point	40	5	15	11	10	14	150	34	4	3
Order Quantity	314	24	122	87	41	52	1303	200	17	10
Safety Stock	14.6	2.6	7.5	5.7	4.4	5.3	34.9	12.3	1.7	1.8

Table 2 (Q,r) results

2. (Q,r) Inventory Simulation

The primary purpose of simulating the (Q,r) optimization results is to provide an inventory management model derived from the actual demand and costs at the military hospital. The hospital inventory management system, Micro-MICS, has the ability to set reorder points and reorder quantities, but the warehouse manager does not use these functions. Micro-MICS is not used to determine order amounts or dates; warehouse employees make these decisions. Daily inventory in Micro-MICS was affected by the fact that the warehouse manager did not enter paperwork for receipts and issues from the warehouse on a daily basis. Batching of the paperwork caused actual daily inventories and reorder points to be indiscriminate and the data was not able to provide actual inventory levels at the time of an order.

We built a Monte Carlo inventory simulation model in Microsoft Excel with Crystal Ball. Table 3 shows the first 21 days of the simulation for item 1. We derive the beginning inventory by dividing the average value of inventory for item 1 (\$71.78) by the

cost/unit (\$0.42) for item 1 then rounding up. The daily demand is simulated by a random normal distribution with a mean of 8.48 ($D_i/365$) and a standard deviation of 2.91. We estimate the standard deviation of daily demand (σ) as the square root of the sum of all daily demands (X) divided by the number of days (N) in the year⁷

$$\sigma = \sqrt{\frac{\sum X}{N}}.$$

This method is used because actual daily inventory levels were not available.

An order is placed, noted by a “YES” in the Order Placed column , when the End Inv column is at or below the reorder point (r). Once the order is placed it is shipped for three days then received (Order Rec’d Column) and placed into inventory (Units Rec’d Column) on the fourth day. The simulation does not take into account any specific order day of the week and does not distinguish weekend days from weekdays. The simulation was run for 500 cycles of one year.

⁷ Weinberg and Schumaker, pp. 80-81

Day	Beg		Simulated					Ending		
	Inv Pos	Inv	Order Rec'd	Units Rec'd	Daily Demand	End Inv	B/O Amt	Order Placed?	Inv Pos	Day Due
1	171	171		0	10.60	160	0	NO	160	
2	160	160		0	16.12	144	0	NO	144	
3	144	144		0	6.31	138	0	NO	138	
4	138	138		0	4.59	133	0	NO	133	
5	133	133		0	6.13	127	0	NO	127	
6	127	127		0	10.25	117	0	NO	117	
7	117	117		0	10.23	107	0	NO	107	
8	107	107		0	9.35	97	0	NO	97	
9	97	97		0	11.58	86	0	NO	86	
10	86	86		0	9.42	76	0	NO	76	
11	76	76		0	10.63	66	0	NO	66	
12	66	66		0	9.99	56	0	NO	56	
13	56	56		0	6.00	50	0	NO	50	
14	50	50		0	7.95	42	0	NO	42	
15	42	42		0	11.03	31	0	YES	344	19
16	344	31		0	10.15	21	0	NO	334	
17	334	21		0	6.40	14	0	NO	328	
18	328	14		0	4.38	10	0	NO	323	
19	323	10	YES	314	8.77	315	0	NO	315	
20	315	315		0	8.69	306	0	NO	306	
21	306	306		0	5.12	301	0	NO	301	

Table 3 (Q,r) Monte Carlo Simulation for Item 1

3. (Q,r) Simulation Results

By gathering the annual demand, item prices, and replenishment lead time from the prime vendor invoices, we were able to optimize the order quantity and reorder point, then simulate the daily inventory levels and order frequency. We calculated the Invoice processing cost, Average on-hand inventory value, and the Annual order and holding cost, listed in Table 4 below, for each of the ten items.

	Invoice Processing Cost	Avg On-Hand Inventory Value	Annual Order and Holding Cost (AHO)
Item 1	\$549.15	\$67.36	\$39.75
Item 2	\$713.90	\$86.82	\$49.63
Item 3	\$439.32	\$53.71	\$30.98
Item 4	\$329.49	\$52.25	\$30.73
Item 5	\$658.98	\$123.50	\$64.91
Item 6	\$988.47	\$152.24	\$83.09
Item 7	\$384.41	\$71.34	\$43.49
Item 8	\$549.15	\$91.76	\$52.40
Item 9	\$878.64	\$118.13	\$68.15
Item 10	\$768.81	\$102.23	\$63.55
TOTALS	\$6,260.31	\$919.36	\$526.68

Table 4 Inventory results from the (Q,r) Simulation

The ten items used in the simulation were actually replenished 118 times on 80 different days by the military hospital in 1999. The simulation achieved the same annual demand replenishing 136 times on 115 different days, resulting in 115 invoices.

C. SIMULATION MODIFICATION FOR PERIODIC ORDER POLICY

We modify the original simulation to account for periodic review of the inventory and a maximum of one shipment per week from the prime vendor. We run the modified model for 500 trials and compare inventory and invoice processing costs changes with the original simulation.

1. Simulation Modification

Our modified simulation used the same optimization of (Q,r) as the original simulation, see Appendix B. We assume that the inventory is reviewed every seven days. In order to accomplish this we had to change the way the simulation looks at the optimal

reorder quantity Q^* and reorder point r^* . In the original simulation we place an order when the ending daily inventory dropped below the reorder point r^* , at which time Q^* was ordered. In our modified model, shown in Table 5, we evaluate the ending inventory every seven days.

Obtaining an optimal order quantity Q_p^* in our periodic order policy simulation is difficult⁸, therefore we use an approximate (s,S) inventory policy. To determine whether or not to place an order, we evaluate the ending inventory balance every 7th day. If the ending inventory is at or below r^* an order is placed. If the ending inventory is not below r^* , the forecasted ending inventory for the next order period is evaluated. The simulation does this by multiplying the simulated daily demand by 7 and then adding the reorder point r^* and placing an order if the current ending inventory is less than this calculation.

⁸ Nahmias, pp. 297-298

Day	Beg				Simulated				Ending		
	Inv Pos	Beg Inv	Order Rec'd	Units Rec'd	Daily Demand	End Inv	B/O AMT	Order Placed?	Inv Pos	Day Due	
1	171	171		0	5.86	165	0	NO	165		
2	165	165		0	7.85	157	0	NO	157		
3	157	157		0	8.65	149	0	NO	149		
4	149	149		0	5.27	143	0	NO	143		
5	143	143		0	7.19	136	0	NO	136		
6	136	136		0	10.68	125	0	NO	125		
7	125	125		0	8.18	117	0	NO	117		
8	117	117		0	13.38	104	0	NO	104		
9	104	104		0	5.33	99	0	NO	99		
10	99	99		0	11.38	87	0	NO	87		
11	87	87		0	3.20	84	0	NO	84		
12	84	84		0	10.12	74	0	NO	74		
13	74	74		0	4.74	69	0	NO	69		
14	69	69		0	9.54	60	0	YES	334	18	
15	334	60		0	8.11	51	0	NO	326		
16	326	51		0	7.53	44	0	NO	318		
17	318	44		0	12.53	31	0	NO	306		
18	306	31	YES	274	10.12	296	0	NO	296		
19	296	296		0	10.94	285	0	NO	285		
20	285	285		0	11.86	273	0	NO	273		
21	273	273		0	9.52	263	0	NO	263		

Table 5 Periodic Review Monte Carlo Simulation for Item 1

We know that the optimum reorder quantity is Q^* , but if we are ordering prior to reaching the optimum reorder point r^* and we order Q^* , we will have excess inventory. We minimize our inventory carrying costs by ordering Q_p^* , an amount less than Q^* . We begin with Q^* , subtract the beginning inventory position IP_b on the order day, subtract the daily demand D_d on the order day, then add the backorder BO amount and r^* , where $Q_p^* = Q^* - IP_b - D_d + BO + r^*$ and $IP_b = \text{On hand} + \text{On order} - \text{Previous Backorders}$.

2. Simulation Modification Results

The most significant result from the second simulation is the change in the orders placed during the year. The number of orders for the ten items increased from 136 to

184, but the number of days in which orders were placed fell from a mean of 115 to 51. This is a result of batching orders until Friday and only placing the orders if the criterion is met. Table 6 details the costs associated with procuring and holding inventory in the modified model.

	Invoice Processing Cost	Avg On-Hand Inventory Value	Annual Order and Holding Cost (AHO)
Item 1	\$658.98	\$71.67	\$58.04
Item 2	\$768.81	\$94.89	\$61.25
Item 3	\$329.49	\$55.87	\$54.53
Item 4	\$274.58	\$57.29	\$54.30
Item 5	\$329.49	\$119.80	\$72.28
Item 6	\$329.49	\$166.59	\$82.12
Item 7	\$54.92	\$76.50	\$59.34
Item 8	\$54.92	\$97.11	\$63.75
Item 9	\$54.92	\$131.42	\$71.73
Item 10	\$0.00	\$108.35	\$68.57
TOTALS	\$2,855.58	\$979.48	\$645.90
(Q,r) Totals	\$6,315.23	\$919.20	\$526.68
Difference	-\$3,459.65	\$60.28	\$119.22

Table 6 Inventory Costs for the Periodic Order Policy Simulation

For example, under the modified simulation, the cost of processing invoices decreased from \$6,315 in the (Q,r) model to \$2,800, a savings of \$3,459 (55.65%). Notice the cost decrease in the Invoice Processing Cost column as we move from Item 1 to Item 10. This is because there is only an invoice cost associated with an order if there has not been another item ordered on the same day. For orders with multiple items, we arbitrarily attributed all the cost to the item with the lowest number.

D. ANALYSIS

We ran both simulations and gathered simulated data on the percentage change in order days, annual order and holding costs, and the value of on-hand inventory. We then apply these percentage changes to the entire amount of inventory procured through the prime vendor during the year to estimate the annual costs associated with implementing the periodic review policy. First, we must look at the fixed costs that are associated with the prime vendor program that are not visible to the military hospital. The costs incurred by DOD associated with processing and paying a prime vendor invoice are estimated to be \$73.22/billable hour with a total of 0.75 hours (\$54.92) spent on each invoice from receipt to payment⁹. Next, we look at the cost incurred by the prime vendor for delivery of orders to the military hospital. It is true that this cost is part of the negotiated percentage increase in the DAPA price of the product, but we feel there are efficiencies here. The cost for shipping is estimated at \$35 per order that is shipped UPS or any other small parcel service. The cost for shipping via the prime vendors LTL (less than truckload) carrier is estimated to be \$100 per shipment.

1. Percentage Change in Order Days

The prime vendor invoices retrieved from the military hospital listed 328 separate document numbers. A separate document number is assigned to each invoice processed by the prime vendor and all invoices are paid separately. There are approximately 260

⁹ DSCP, Contracting

possible ordering days during the year, which indicates that there were days when multiple orders were placed. This was evident while analyzing the original data, where we found approximately 80 (24%) EDO's and 248 (76%) JITOs. Under the current contract EDO and JITO orders are required to be on separate invoices because of the separate delivery requirements. An item on an invoice is either shipped with all other items or it is cancelled. Items are not backordered from the prime vendor. Taking into account available workdays, the available days for processing orders falls below 260 and implies that there were days when multiple JITO orders were placed.

The military hospital processed 328 invoices, for all items procured through the prime vendor, on 248 separate days resulting in a cost of \$18,012. The first simulation, (Q,r) policy, resulted in 115 order dates and 115 invoices, a 65% savings in invoice processing. The second simulation, periodic review policy, decreases the order days and invoices processed to 51 days during the year. This is a decrease of greater than 84% in invoices costs and 79% in order days. The decrease in order days also increases the size of the orders processed. Orders processed once a week have a greater chance of being large enough to be placed on the prime vendor's LTL carrier. The estimated shipping cost to the prime vendor of shipping all 248 order days by UPS is \$8,680, an average cost of \$35 per shipment. The second simulation batches orders for processing on Friday and enables the prime vendor use its LTL carrier at an estimated cost of \$100 per shipment. The ability of the prime vendor to consolidate shipping results in potential transportation savings of 41% ($1 - \$5,100 / \$8,680$).

2. Percent Change in Annual Holding and Ordering Cost

The change in the annual holding and ordering costs is directly related to the number of times an order is placed and the amount of inventory that is located in the warehouse at any given time. The holding and ordering costs, see Appendix C, increased by an average of 18.4%, from a mean of \$524 to a mean of \$644 during the second simulation. This change is because average inventory levels are greater with a periodic order policy than with a (Q,r) policy, increasing the cost associated with holding inventory.

E. TOTAL ESTIMATED SAVINGS

The Naval Hospital in Lemoore, CA spent \$22,444 on the 10 items in our simulation in fiscal year 2000, approximately 33% of the total amount spent (\$68,836) on prime vendor items. Invoice processing cost DOD \$18,012 and shipping costs for the prime vendor were \$8680. Because the hospital does not keep detailed records on ordering and holding costs, we estimate them with the (Q,r) simulation results and observe \$523 for the 10 items. We assume that the total AHO costs for Naval Hospital Lemoore, CA would be \$1,569 (3 X 523). The periodic order policy simulation resulted in shipping costs decreasing 41%, annual holding and ordering costs increasing by 18.48%, and invoice processing costs decreasing by 84%.

	Current	Periodic Review Policy	Savings
Transportation	\$235,200.00	\$138,768.00	\$96,432.00
Annual Holding and Ordering	\$38,196.66	\$45,255.40	-\$7,058.74
Invoice Processing	\$461,328.00	\$73,812.48	\$387,515.52
Total	\$734,724.66	\$257,835.88	\$476,888.78

Table 7 Estimated Annual Savings for 28 Small Naval Hospitals

We include 28 Navy medical facilities in our model that each have total procurements of less than \$150,000 annually through the prime vendor. The total amount procured is \$1,637,000, including Naval Hospital Lemoore. We assume that the AHO for all facilities will be equal to \$525 for every \$22,500 of inventory procured, for a total of \$38,196 in AHO costs (see Table 7). We assume that each facility processes at least 300 invoices per year, for a total cost of \$461,328, and receive at least 240 shipments, for a total transportation cost of \$235,200.

The periodic order policy reveals a 41% decrease in shipping costs to the prime vendor with an overall decrease in shipments of 79%. The increase in inventory holding costs is less than 2% of the savings generated from processing fewer invoices. The total estimated savings from the periodic review inventory policy are greater than \$475,000.

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IV. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

Our thesis addressed the primary purpose of providing a periodic review inventory policy to support inventory management needs at the small military hospital. We developed a periodic review policy simulation that used historical data from the Naval Hospital Lemoore, CA and data from our (Q,r) optimization. We used the results to extrapolate our predictions to small medical facilities that could benefit from the periodic review policy. We looked at costs associated with invoice processing, ordering and holding inventory, and transportation. Our research estimated potential savings of \$476,888 from small military hospitals.

B. CONCLUDING COMMENTS

The Prime Vendor Program is making many advances in contract negotiations at the headquarters level. The Stockless Option, discussed in Chapter II, is one example of partnering with the prime vendor in order to achieve greater efficiency. But, for the most part, the contracts only provide a common framework for the region supported by the prime vendor. All facilities are encouraged to process orders daily in order to achieve decreased inventories, but this may not always be the best option. This was revealed in our periodic review simulation where daily ordering saved \$7,000 in inventory holding costs, but resulted in an increase of greater than \$350,000 in administrative costs. There are opportunities for individual military hospitals to realize efficiencies between

themselves and the supporting prime vendor that are not currently, and were not at the time of the contract signing, evident to DSCP. The transportation savings of 42% are not seen by the military hospital, but are realized by the prime vendor. This is an area of opportunity for partnership between the prime vendor and the hospital. The prime vendor could pass on a percentage of the total transportation savings to the military hospital by decreasing the visible DAPA price. Currently, military hospitals are not granted authority to negotiate DAPA prices with the prime vendor. In addition, invoice processing costs are neither paid by nor visible to the military hospital. These two main areas of potential savings are not in the control of military hospitals, decreasing incentive for change.

Processing purchase requests for medical items prior to the prime vendor program cost greater than \$500 per procurement and could take greater than 30 days. The prime vendor program has decreased both cost and time, further decreasing the incentive to explore additional areas of inventory efficiencies.

C. AREAS FOR FUTHER RESEARCH

1. Consignment

The concept of consignment, discussed in Chapter II, is an area that is being explored by progressive commercial distributors. As our Automated Information Systems, such as DMLSS, become more advanced and standardized throughout DOD medicine and our ability to process and pay invoices becomes instantaneous, we will be able to explore the benefits of consignment programs. We are not currently at a level of

automation and standardization that would be necessary for the effective development of consignment programs.

2. Training of Medical Logistics Personnel

Most Navy hospitals have one medical logistian that is the head of the supply department. This person is an Officer that has attended Navy Medicine's Fiscal and Supply School, an introductory course that does not address inventory management theory. The course spends 50% of its time on fiscal matters and 50% on supply issues, mostly rules, regulations, and forms. Also, enlisted personnel working in hospital warehouses are not routinely trained in supply functions. They are medically trained Hospital Corpsman spending a short amount of their time in an administrative function. The Hospital Corpsman rotates through the supply department approximately every nine months. We believe that this is an area that would warrant further research. Would Navy medical logistics benefit from a separate school concentrated in inventory theory and practice for its officers and would there be benefits from developing an enlisted school for medical logistics?

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APPENDIX A: PRIME VENDOR INVOICES

Stock Number	PV Order #	Doc #	Order Date	Order Type	Del Amt	Unit \$	Extented \$
6505-01-330-6250	35840L7510	AF10	1/23/00	JITO	6	\$7.40	\$44.40
6505-01-330-6250	35840L7510	AF35	2/11/00	JITO	5	\$7.40	\$37.00
6505-01-330-6250	35840L7510	AF73	3/29/00	JITO	6	\$7.40	\$44.40
6505-01-330-6250	35840L7510	AG78	7/19/00	JITO	6	\$7.40	\$44.40
6505-01-330-6267	07062B2324	AG38	6/1/00	JITO	6	\$4.59	\$27.54
6505-01-330-6267	07062B2324	AG53	6/15/00	JITO	2	\$4.59	\$9.18
6505-01-330-6267	07062B2324	AG57	6/20/00	JITO	10	\$4.59	\$45.90
6505-01-330-6267	07062B2324	AG61	6/22/00	JITO	10	\$4.59	\$45.90
6505-01-330-6267	07062B2324	AG77	7/17/00	JITO	10	\$4.59	\$45.90
6505-01-330-6267	07062B2324	AG78	7/19/00	JITO	10	\$4.59	\$45.90
6505-01-330-6267	35840L7500	AE93	1/7/00	JITO	7	\$5.23	\$36.61
6505-01-330-6267	35840L7500	AE98	1/11/00	JITO	3	\$5.23	\$15.69
6505-01-330-6267	35840L7500	AF01	1/11/00	JITO	15	\$5.23	\$78.45
6505-01-330-6267	35840L7500	AF16	1/26/00	JITO	7	\$5.23	\$36.61
6505-01-330-6267	35840L7500	AF32	2/7/00	JITO	9	\$5.23	\$47.07
6505-01-330-6267	35840L7500	AF40	2/17/00	JITO	10	\$5.23	\$52.30
6505-01-330-6267	35840L7500	AF71	3/28/00	JITO	10	\$5.23	\$52.30
6505-01-330-6267	35840L7500	AG16	5/11/00	JITO	6	\$5.23	\$31.38
6505-01-330-6267	35840L7500	AG25	5/18/00	JITO	6	\$5.23	\$31.38
6505-01-330-6267	35840L7500	AG08	5/1/00		8	\$5.23	\$41.84
6505-01-330-6269	35840L8000	AF66	3/16/00	JITO	5	\$4.21	\$21.05
6505-01-330-6269	35840L8000	AG70	7/5/00	JITO	6	\$4.21	\$25.26
6505-01-330-6277	35840L6350	AG49	6/12/00	JITO	8	\$11.10	\$88.80
6505-01-330-8926	3584R520001	AF03	1/13/00	JITO	6	\$7.83	\$46.98
6505-01-330-8926	3584R520001	AF17	1/28/00	JITO	5	\$7.83	\$39.15
6505-01-330-8926	3584R520001	AF44	2/23/00	JITO	7	\$7.83	\$54.81
6505-01-330-8926	3584R520001	AF51	3/2/00	JITO	6	\$7.83	\$46.98
6505-01-330-8926	3584R520001	AG25	5/18/00	JITO	5	\$7.83	\$39.15
6505-01-330-8926	3584R520001	AG49	6/12/00	JITO	8	\$7.83	\$62.64
6505-01-330-8926	3584R520001	AG70	7/5/00	JITO	5	\$7.83	\$39.15
6505-01-330-8932	3584R500001	AF23	2/2/00	JITO	6	\$8.51	\$51.06
6505-01-330-8932	3584R500001	AF35	2/11/00	JITO	5	\$8.51	\$42.55
6505-01-330-8932	3584R500001	AF62	3/15/00	JITO	7	\$8.51	\$59.57
6505-01-330-8932	3584R500001	AG61	6/22/00	JITO	6	\$8.51	\$51.06
6505-01-330-8932	3584R500001	AG82	7/25/00	JITO	6	\$8.51	\$51.06
6505-01-330-8932	3584R500001	AG12	5/9/00		6	\$8.51	\$51.06
6505-01-330-9999	3583005330	AG19	5/11/00	JITO	1	\$257.84	\$257.84
6505-01-331-8945	35840L8002	AG66	6/26/00	JITO	2	\$18.64	\$37.28
6505-LL-L00-0063	07062B7477	AF32	2/7/00	JITO	10	\$25.85	\$258.50
6505-LL-L00-0063	07062B7477	AF62	3/15/00	JITO	10	\$25.85	\$258.50
6505-LL-L00-0063	07062B7477	AG25	5/18/00	JITO	6	\$25.85	\$155.10
6505-LL-L00-0063	07062B7477	AG38	6/1/00	JITO	8	\$25.85	\$206.80

6505-LL-L00-0063	07062B7477	AG43	6/5/00	JITO	1	\$25.85	\$25.85
6505-LL-L00-0063	07062B7477	AG78	7/19/00	JITO	1	\$25.85	\$25.85
6510-00-018-6184		AG08	5/1/00		1	\$143.42	\$143.42
6510-00-116-1311	3583006939	AF10	1/23/00	JITO	2	\$67.47	\$134.94
6510-00-116-1311	3583006939	AG38	6/1/00	JITO	1	\$67.47	\$67.47
6510-00-200-3030	3583002059	AG63	6/23/00	JITO	2	\$30.02	\$60.04
6510-00-559-6130	3583001375	AE93	1/7/00	JITO	3	\$18.93	\$56.79
6510-00-559-6130	3583001375	AF32	2/7/00	JITO	2	\$18.93	\$37.86
6510-00-559-6130	3583001375	AF56	3/8/00	JITO	2	\$18.93	\$37.86
6510-00-559-6130	3583001375	AF68	3/24/00	JITO	3	\$18.93	\$56.79
6510-00-559-6130	3583001375	AG15	5/11/00	JITO	2	\$18.93	\$37.86
6510-00-559-6130	3583001375	AG38	6/1/00	JITO	3	\$18.93	\$56.79
6510-00-559-6130	3583001375	AG66	6/26/00	JITO	1	\$18.93	\$18.93
6510-00-559-6130	3583001375	AG78	7/19/00	JITO	3	\$19.69	\$59.07
6510-00-597-7469	3460004634	AE95	1/10/00	JITO	4	\$27.54	\$110.16
6510-00-597-7469	3460004634	AG73	7/13/00	JITO	2	\$27.54	\$55.08
6510-00-597-7469	3460004634	AG82	7/25/00	JITO	4	\$27.54	\$110.16
6510-00-597-7469	3460004634	AG08	5/1/00		4	\$27.54	\$110.16
6510-00-721-9808	3583002913	AF38	2/15/00	JITO	2	\$48.11	\$96.22
6510-00-721-9808	3583002913	AG02	5/1/00	JITO	2	\$48.11	\$96.22
6510-00-782-2698	3583002556	AG04	5/2/00	JITO	2	\$77.43	\$154.86
6510-00-782-2698	3583002556	AG45	6/7/00	JITO	2	\$77.43	\$154.86
6510-00-782-2698	3583002556	AG66	6/26/00	JITO	1	\$77.43	\$77.43
6510-00-782-2700	3583002252	AG04	5/2/00	JITO	2	\$77.06	\$154.12
6510-00-786-3736	3583006818	AE95	1/10/00	JITO	4	\$22.55	\$90.20
6510-00-786-3736	3583006818	AF62	3/15/00	JITO	4	\$22.55	\$90.20
6510-00-786-3736	3583006818	AG38	6/1/00	JITO	3	\$22.55	\$67.65
6510-00-786-3736	3583006818	AG73	7/13/00	JITO	5	\$22.55	\$112.75
6510-00-935-5821	723207337	AG31	5/23/00	JITO	10	\$14.46	\$144.60
6510-00-935-5821	723207337	AG78	7/19/00	JITO	4	\$14.46	\$57.84
6510-00-935-5822	3596000326	AF10	1/23/00	JITO	10	\$6.82	\$68.20
6510-00-935-5822	3596000326	AF62	3/15/00	JITO	2	\$68.18	\$136.36
6510-00-935-5822	3596000326	AG31	5/23/00	JITO	10	\$6.82	\$68.20
6510-00-935-5822	3596000326	AG78	7/19/00	JITO	4	\$6.82	\$27.28
6510-01-060-6370	4509015283	AG21	5/17/00	EDO	10	\$15.53	\$155.30
6510-01-060-6370	4509015283	AF51	3/2/00	JITO	12	\$15.53	\$186.36
6510-LL-L00-0058	3460006902	AG66	6/26/00	JITO	1	\$21.36	\$21.36
6510-LL-L00-0058	3460006902	AG75	7/14/00	JITO	3	\$21.36	\$64.08
6510-LL-L00-0081	4509001582	AG60	6/22/00	EDO	6	\$43.98	\$263.88
6510-LL-L00-0081	4509001582	AF73	3/29/00	JITO	6	\$43.98	\$263.88
6510-LL-L00-0081	4509001582	AG02	5/1/00	JITO	6	\$43.98	\$263.88
6510-LL-L00-0086	3642062224	AF74	3/29/00	EDO	5	\$61.57	\$307.85
6510-LL-L00-0086	3642062224	AG21	5/17/00	EDO	4	\$61.57	\$246.28
6510-LL-L00-0086	3642062224	AG73	7/13/00	JITO	4	\$61.57	\$246.28
6515-00-116-1311	3583006939	AG67	6/30/00	JITO	1	\$67.47	\$67.47
6515-00-324-5500		AG08	5/1/00		15	\$4.64	\$69.60
6515-00-754-0406		AG08	5/1/00		2	\$33.53	\$67.06
6515-00-754-0412		AG08	5/1/00	EDO	16	\$9.85	\$157.60

6515-00-754-2834	723305196	AF68	3/24/00	JITO	5	\$3.83	\$19.15
6515-00-754-2834	723305196	AG24	5/17/00	JITO	10	\$3.83	\$38.30
6515-00-754-2834	723305196	AG54	6/19/00	JITO	20	\$3.83	\$76.60
6515-00-782-2621	4509001818	AF18	1/28/00	EDO	30	\$5.87	\$176.10
6515-00-782-2621	4509001818	AG06	5/4/00	EDO	30	\$5.87	\$176.10
	3022258062W						
6515-00-905-1473	C	AG28	5/19/00	JITO	1	\$29.52	\$29.52
6515-00-982-4205	723309626	AF50	3/1/00	JITO	40	\$8.62	\$344.80
6515-00-982-4205	723309626	AG54	6/19/00	JITO	40	\$8.62	\$344.80
6515-01-158-8010	6783052432	AG31	5/23/00	JITO	2	\$18.55	\$37.10
6515-01-158-8081	6783052432	AG61	6/22/00	JITO	4	\$18.55	\$74.20
6515-01-238-5612	3584332220	AG61	6/22/00	JITO	3	\$212.20	\$636.60
6515-01-257-8463	707002034	AG17	5/11/00	EDO	3	\$37.77	\$113.31
6515-01-257-8463	707002034	AG39	6/1/00	EDO	2	\$37.77	\$75.54
6515-01-269-6929	07062C7415	AG46	6/9/00	JITO	2	\$23.49	\$46.98
6515-01-278-9847	07062C5519	AG50	6/12/00	EDO	3	\$51.06	\$153.18
6515-01-286-5311	368384810055	AG45	6/7/00	JITO	2	\$112.25	\$224.50
6515-01-437-7602	5595000220	AG37	5/30/00	JITO	5	\$53.13	\$265.65
6515-01-437-7602	5595000220	AG70	7/5/00	JITO	5	\$53.13	\$265.65
6515-01-437-7609	5595000440	AF16	1/26/00	JITO	6	\$60.89	\$365.34
6515-01-437-7609	5595000440	AF56	3/8/00	JITO	6	\$60.89	\$365.34
6515-01-437-7609	5595000440	AG28	5/19/00	JITO	2	\$53.13	\$106.26
6515-01-437-7609	5595000440	AG37	5/30/00	JITO	5	\$53.13	\$265.65
6515-01-437-7609	5595000440	AG51	6/13/00	JITO	5	\$53.13	\$265.65
6515-01-437-7609	5595000440	AG67	6/30/00	JITO	5	\$53.13	\$265.65
6515-01-437-7609	5595000440	AG82	7/25/00	JITO	5	\$53.13	\$265.65
6515-01-437-7611	5595000330	AF03	1/13/00	JITO	6	\$60.89	\$365.34
6515-01-437-7611	5595000330	AF32	2/7/00	JITO	7	\$60.89	\$426.23
6515-01-437-7611	5595000330	AF50	3/1/00	JITO	8	\$60.89	\$487.12
6515-01-437-7611	5595000330	AF73	3/29/00	JITO	6	\$60.89	\$365.34
6515-01-437-7611	5595000330	AG15	5/11/00	JITO	5	\$53.13	\$265.65
6515-01-437-7611	5595000330	AG31	5/23/00	JITO	5	\$53.13	\$265.65
6515-01-437-7611	5595000330	AG49	6/12/00	JITO	5	\$53.13	\$265.65
6515-01-437-7611	5595000330	AG61	6/22/00	JITO	5	\$53.13	\$265.65
6515-01-437-7611	5595000330	AG73	7/13/00	JITO	1	\$53.13	\$53.13
6515-01-437-7611	5595000330	AG82	7/25/00	JITO	5	\$53.13	\$265.65
6515-LL-L00-0056	723329461	AE88	1/3/00	JITO	5	\$49.19	\$245.95
6515-LL-L00-0057	723309300	AE88	1/3/00	JITO	3	\$178.69	\$536.07
6515-LL-L00-0087	3642062248	AF74	3/29/00	EDO	2	\$48.31	\$96.62
6515-LL-L00-0087	3642062248	AG07	5/5/00	EDO	4	\$48.31	\$193.24
6515-LL-L00-0087	3642062248	AG74	7/13/00	EDO	2	\$48.31	\$96.62
	070757651193						
6515-LL-L00-0092	0C	AG38	6/1/00	JITO	2	\$76.47	\$152.94
	070757651930						
6515-LL-L00-0092	C	AG82	7/25/00	JITO	1	\$76.47	\$76.47
6515-LL-L00-0108	7052D7284	AG09	5/9/00	JITO	1	\$296.76	\$296.76
6515-LL-L00-0109	7052D7285	AF21	1/31/00	JITO	1	\$296.76	\$296.76
6515-LL-L00-0109	7052D7285	AG04	5/2/00	JITO	1	\$296.76	\$296.76

6515-LL-L00-0109	7052D7285	AG66	6/26/00	JITO	6	\$49.78	\$298.68
6515-LL-L00-0118	4251484303	AG22	5/17/00	JITO	2	\$44.67	\$89.34
6515-LL-L00-0132	3460003060	AE95	1/10/00	JITO	3	\$98.92	\$296.76
6515-LL-L00-0132	3460003060	AF44	2/23/00	JITO	4	\$85.91	\$343.64
6515-LL-L00-0132	3460003060	AG05	5/4/00	JITO	4	\$85.91	\$343.64
6515-LL-L00-0134	3460003056	AF40	2/17/00	JITO	2	\$81.20	\$162.40
6515-LL-L00-0134	3460003056	AG12	5/9/00		4	\$81.20	\$324.80
6515-LL-L00-0135	3460003055	AF40	2/17/00	JITO	2	\$81.20	\$162.40
6515-LL-L00-0135	3460003055	AG12	5/9/00		4	\$81.20	\$324.80
6515-LL-L00-0135	3460003056	AG82	7/25/00	JITO	4	\$81.20	\$324.80
6515-LL-L00-0136	3460003062	AF35	2/11/00	JITO	3	\$85.91	\$257.73
6515-LL-L00-0136	3460003062	AG24	5/17/00	JITO	4	\$85.91	\$343.64
6515-LL-L00-0159	3583006014	AG58	6/22/00	JITO	1	\$57.80	\$57.80
6515-LL-L00-0193	07062C6537	AG55	6/20/00	JITO	6	\$153.17	\$919.02
6515-LL-L00-0194	07062C7562	AG56	6/20/00	EDO	3	\$61.29	\$183.87
6515-LL-L00-0195	07062C7451	AG55	6/20/00	JITO	5	\$63.82	\$319.10
6515-LL-L00-0196	07062C6757	AG62	6/23/00	EDO	1	\$325.13	\$325.13
6515-LL-L00-0196	07062C6757	AG55	6/20/00	JITO	1	\$325.13	\$325.13
6516-01-149-8840		AG08	5/1/00		2	\$59.56	\$119.12
6530-00-133-4299	0707V1445020	AG15	5/11/00	JITO	2	\$55.01	\$110.02
6530-00-133-4299	0707V1445020	AG51	6/13/00	JITO	2	\$55.01	\$110.02
6530-00-133-4299	0707V1445020	AG71	7/6/00	JITO	2	\$55.01	\$110.02
6530-00-133-4299	0707V1445020	AG82	7/25/00	JITO	8	\$13.75	\$110.00
6530-00-494-8120	5216489711	AG32	5/25/00	JITO	2	\$18.03	\$36.06
6530-00-494-8120	5216489711	AG66	6/26/00	JITO	2	\$18.03	\$36.06
6530-00-494-8120	5216489711	AG82	7/25/00	JITO	2	\$18.03	\$36.06
6530-00-836-8134	6709H30005	AG22	5/17/00	JITO	2	\$21.27	\$42.54
6530-00-837-7472	5216004928	AF02	1/13/00	JITO	10	\$11.17	\$111.70
6530-00-837-7472	5216004928	AF33	2/10/00	JITO	9	\$11.17	\$100.53
6530-00-837-7472	5216004928	AF44	2/23/00	JITO	7	\$11.17	\$78.19
6530-00-837-7472	5216004928	AF62	3/15/00	JITO	7	\$11.17	\$78.19
6530-00-837-7472	5216004928	AG05	5/4/00	JITO	6	\$11.17	\$67.02
6530-00-837-7472	5216004928	AG24	5/17/00	JITO	8	\$11.17	\$89.36
6530-00-837-7472	5216004928	AG38	6/1/00	JITO	8	\$11.17	\$89.36
6530-00-837-7472	5216004928	AG66	6/26/00	JITO	10	\$11.17	\$111.70
6530-00-837-7472	5216004928	AG70	7/5/00	JITO	5	\$11.17	\$55.85
6530-00-837-7472	5216004928	AG82	7/25/00	JITO	6	\$11.17	\$67.02
6530-00-996-5600	705009358	AG79	7/20/00	JITO	3	\$27.23	\$81.69
6530-01-030-6861	5216452022	AG82	7/25/00	JITO	2	\$32.55	\$65.10
6530-01-036-7260	3642088541	AG15	5/11/00	JITO	2	\$84.58	\$169.16
6530-01-049-0428	5216467575	AG66	6/26/00	JITO	1	\$14.36	\$14.36
6530-01-092-3914	468301239149	AF28	2/3/00	EDO	4	\$20.73	\$82.92
6530-01-092-3914	468301239149	AF63	3/15/00	EDO	8	\$20.73	\$165.84
6530-01-092-3914	468301239149	AG30	5/23/00	EDO	5	\$20.73	\$103.65
6530-01-092-3914	468301239149	AG05	5/4/00	JITO	6	\$20.73	\$124.38
6530-01-092-3914	4452TI916183	AG48	6/12/00	JITO	10	\$19.44	\$194.40
6530-01-092-3914	4452TI916183	AG79	7/20/00	JITO	5	\$19.44	\$97.20
6530-01-110-1369	8583004014	AG66	6/26/00	JITO	2	\$56.66	\$113.32

6530-01-119-0015	3583007105	AE90	1/3/00	JITO	4	\$25.47	\$101.88
6530-01-119-0015	3583007105	AF10	1/23/00	JITO	6	\$25.47	\$152.82
6530-01-119-0015	3583007105	AF23	2/2/00	JITO	4	\$25.47	\$101.88
6530-01-119-0015	3583007105	AF44	2/23/00	JITO	6	\$25.47	\$152.82
6530-01-119-0015	3583007105	AF62	3/15/00	JITO	8	\$25.47	\$203.76
6530-01-119-0015	3583007105	AG45	6/7/00	JITO	4	\$25.47	\$101.88
6530-01-119-0015	3583007105	AG58	6/22/00	JITO	6	\$25.47	\$152.82
6530-01-119-0015	3583007105	AG73	7/13/00	JITO	6	\$26.50	\$159.00
6530-01-172-6992	3583008980	AF78	5/11/00	EDO	1	\$66.90	\$66.90
6530-01-172-6992	3583008980	AG72	7/10/00	JITO	3	\$66.90	\$200.70
6530-01-172-6992	3583008980	AG12	5/9/00		2	\$66.90	\$133.80
6530-01-257-8447	705009174	AG22	5/17/00	JITO	2	\$87.13	\$174.26
6530-01-419-0744	358385098A	AG45	6/7/00	JITO	3	\$51.85	\$155.55
6530-01-419-0744	35838509SA	AG79	7/20/00	JITO	4	\$51.85	\$207.40
6530-01-419-0744	35838509SA	AG12	5/9/00		2	\$51.85	\$103.70
6530-LL-L00-0032	705029750	AE95	1/10/00	JITO	4	\$74.86	\$299.44
6530-LL-L00-0032	705029750	AF35	2/11/00	JITO	3	\$74.86	\$224.58
6530-LL-L00-0032	705029750	AF62	3/15/00	JITO	3	\$74.86	\$224.58
6530-LL-L00-0032	705029750	AG15	5/11/00	JITO	4	\$74.86	\$299.44
6530-LL-L00-0032	705029750	AG24	5/17/00	JITO	1	\$74.86	\$74.86
6530-LL-L00-0032	705029750	AG71	7/6/00	JITO	4	\$74.86	\$299.44
6530-LL-L00-0032	7050299750	AG26	5/18/00	EDO	4	\$74.86	\$299.44
6530-LL-L00-0072	705008474	AG73	7/13/00	JITO	4	\$39.10	\$156.40
6532-01-319-5121	3642052010	AG82	7/25/00	JITO	1	\$25.46	\$25.46
6532-01-350-1824	3642052018	AF02	1/13/00	JITO	5	\$22.37	\$111.85
6532-01-350-1824	3642052018	AF76	3/31/00	JITO	6	\$22.37	\$134.22
6532-01-350-1824	3642052018	AG35	5/30/00	JITO	3	\$22.37	\$67.11
6532-01-350-1824	3642052018	AG52	6/21/00	JITO	3	\$22.37	\$67.11
6532-01-350-1824	3642052018	AG66	6/26/00	JITO	3	\$22.37	\$67.11
6532-01-350-1824	3642052018	AG79	7/20/00	JITO	4	\$22.37	\$89.48
6630-01-061-2282	723366452	AG04	5/2/00	JITO	1	\$59.70	\$59.70
6630-01-061-2282	723366452	AG24	5/17/00	JITO	1	\$59.70	\$59.70
6630-01-061-2282	723366452	AG54	6/19/00	JITO	1	\$59.70	\$59.70
6630-01-066-0416	723366510	AF67	3/21/00	JITO	2	\$180.69	\$361.38
6630-01-066-0416	723366510	AG24	5/17/00	JITO	1	\$180.69	\$180.69
6630-01-066-0416	723366510	AG45	6/7/00	JITO	1	\$180.69	\$180.69
6630-01-066-0416	723366510	AG71	7/6/00	JITO	1	\$180.69	\$180.69
6630-01-066-0416	723366510	AG79	7/20/00	JITO	2	\$180.69	\$361.38
6630-01-230-9964	35831500SA	AG77	7/17/00	JITO	5	\$42.81	\$214.05
6630-LL-L00-0043	723369783	AG54	6/19/00	JITO	1	\$177.28	\$177.28
7360-01-387-1316	6709016112	AF22	1/31/00	EDO	10	\$22.15	\$221.50
7360-01-387-1316	6709016112	AG39	6/1/00	EDO	4	\$22.15	\$88.60
7360-01-387-1316	6709016112	AF10	1/23/00	JITO	1	\$22.15	\$22.15
7930-01-312-5568	6755167308	AG82	7/25/00	JITO	3	\$70.20	\$210.60
	158030565	AF53	3/2/00	JITO	1	\$85.09	\$85.09
	158030565	AG81	7/25/00	JITO	2	\$85.09	\$170.18
	158030570	AF04	1/14/00	JITO	1	\$340.37	\$340.37
	158030570	AF53	3/2/00	JITO	1	\$340.37	\$340.37

158030570	AG81	7/25/00	JITO	3	\$85.09	\$255.27
158030575	AF53	3/2/00	JITO	1	\$340.37	\$340.37
158030575	AG09	5/9/00	JITO	2	\$85.09	\$170.18
158030575	AG40	6/2/00	JITO	1	\$85.09	\$85.09
158030575	AG76	7/17/00	JITO	1	\$85.09	\$85.09
158030575	AG81	7/25/00	JITO	3	\$85.09	\$255.27
158030580	AG40	6/2/00	JITO	1	\$85.09	\$85.09
158030580	AG64	6/23/00	JITO	2	\$85.09	\$170.18
158030580	AG81	7/25/00	JITO	2	\$85.09	\$170.18
158030585	AG40	6/2/00	JITO	2	\$85.09	\$170.18
158030585	AG81	7/25/00	JITO	2	\$85.09	\$170.18
570174209	AG44	6/5/00	EDO	1	\$397.85	\$397.85
620021508	AF54	3/7/00	EDO	2	\$42.82	\$85.64
620021510	AF55	3/7/00	JITO	2	\$42.82	\$85.64
620021512	AF55	3/7/00	JITO	2	\$42.82	\$85.64
620021514	AF54	3/7/00	EDO	2	\$42.82	\$85.64
620021516	AF54	3/7/00	EDO	2	\$42.82	\$85.64
620021518	AF54	3/7/00	EDO	2	\$42.82	\$85.64
620021520	AF55	3/7/00	JITO	2	\$42.82	\$85.64
620021524	AF54	3/7/00	EDO	2	\$42.82	\$85.64
620021803	AF54	3/7/00	EDO	2	\$29.52	\$59.04
620021804	AF54	3/7/00	EDO	2	\$29.52	\$59.04
620021805	AF54	3/7/00	EDO	2	\$29.52	\$59.04
620021903	AF54	3/7/00	EDO	2	\$23.19	\$46.38
620021904	AF54	3/7/00	EDO	2	\$23.19	\$46.38
620021905	AF54	3/7/00	EDO	2	\$23.19	\$46.38
620022004	AF54	3/7/00	EDO	2	\$29.24	\$58.48
620022005	AF54	3/7/00	EDO	2	\$29.24	\$58.48
620022103	AF54	3/7/00	EDO	2	\$23.19	\$46.38
620022104	AF54	3/7/00	EDO	2	\$23.19	\$46.38
620022105	AF54	3/7/00	EDO	2	\$23.19	\$46.38
705008337	AF64	3/15/00	JITO	1	\$32.46	\$32.46
705008337	AG64	6/23/00	JITO	1	\$32.46	\$32.46
705008337	AG68	6/30/00	JITO	1	\$32.46	\$32.46
706281064	AF10	1/23/00	JITO	2	\$4.98	\$9.96
707004458	AG80	7/20/00	JITO	1	\$154.57	\$154.57
723301603	AE88	1/3/00	JITO	16	\$8.14	\$130.24
723301604	AE88	1/3/00	JITO	16	\$9.56	\$152.96
723301627	AF64	3/15/00	JITO	1	\$52.58	\$52.58
723305136	AF57	3/13/00	JITO	1	\$55.21	\$55.21
723309309	AE95	1/10/00	JITO	4	\$157.42	\$629.68
723309585	AE95	1/10/00	JITO	3	\$37.53	\$112.59
723366418	AF68	3/24/00	JITO	4	\$6.62	\$26.48
723366432	AF67	3/21/00	JITO	1	\$65.56	\$65.56
723366432	AF68	3/24/00	JITO	8	\$6.56	\$52.48
723366452	AF23	2/2/00	JITO	1	\$59.70	\$59.70
723366452	AF62	3/15/00	JITO	1	\$59.70	\$59.70
723366514	AF67	3/21/00	JITO	2	\$184.12	\$368.24

723367213	AF68	3/24/00	JITO	15	\$6.29	\$94.35
723367253	AF68	3/24/00	JITO	4	\$113.65	\$454.60
723367287	AG74	7/13/00	EDO	1	\$167.94	\$167.94
723405182	AF12	1/23/00	JITO	4	\$28.73	\$114.92
1125023116	AG34	5/25/00	EDO	1	\$46.28	\$46.28
1125023116	AF15	1/25/00	JITO	1	\$43.82	\$43.82
1475001231	AF24	2/2/00	JITO	1	\$6.84	\$6.84
2300006988	AF75	3/31/00	JITO	2	\$36.33	\$72.66
2464008818	AF28	2/3/00	EDO	1	\$33.63	\$33.63
2464008818	AF69	3/24/00	EDO	5	\$33.63	\$168.15
3022000705	AE90	1/3/00	JITO	15	\$4.53	\$67.95
3280001750	AF26	2/3/00	JITO	1	\$26.17	\$26.17
3460001298	AG69	6/30/00	EDO	1	\$95.91	\$95.91
3460001298	AF48	2/25/00	JITO	1	\$95.94	\$95.94
3460001298	AG33	5/25/00	JITO	1	\$95.94	\$95.94
3460003053	AF35	2/11/00	JITO	3	\$81.20	\$243.60
3460003053	AF62	3/15/00	JITO	4	\$81.20	\$324.80
3460003068	AF35	2/11/00	JITO	3	\$85.91	\$257.73
3460004056	AF62	3/15/00	JITO	10	\$36.70	\$367.00
3460008755	AF14	1/25/00	JITO	3	\$2.98	\$8.94
3460008756	AG64	6/23/00	JITO	1	\$38.03	\$38.03
3461005942	AG42	6/5/00	EDO	9	\$28.91	\$260.19
3461005943	AF20	1/31/00	JITO	6	\$35.40	\$212.40
3461005943	AG41	6/2/00	JITO	6	\$35.40	\$212.40
3461005952	AF19	1/31/00	EDO	6	\$28.91	\$173.46
3461005952	AG42	6/5/00	EDO	9	\$28.91	\$260.19
3461005953	AF20	1/31/00	JITO	3	\$35.40	\$106.20
3461005953	AG41	6/2/00	JITO	5	\$35.40	\$177.00
3461006732	AF19	1/31/00	EDO	6	\$28.91	\$173.46
3461006862	AE92	1/7/00	EDO	3	\$28.91	\$86.73
3461006863	AE92	1/7/00	EDO	3	\$39.59	\$118.77
3461007391	AF52	3/2/00	JITO	2	\$5.36	\$10.72
3583002252	AF62	3/15/00	JITO	2	\$77.06	\$154.12
3583002252	AF76	3/31/00	JITO	2	\$77.06	\$154.12
3583002556	AE93	1/7/00	JITO	3	\$77.43	\$232.29
3583002556	AF43	2/18/00	JITO	2	\$77.43	\$154.86
3583003416	AG23	5/17/00	JITO	2	\$45.34	\$90.68
3583003728	AG23	5/17/00	JITO	2	\$45.34	\$90.68
3583004041	AF23	2/2/00	JITO	1	\$56.66	\$56.66
3583005345	AG19	5/11/00	JITO	1	\$246.02	\$246.02
3583005480	AG19	5/11/00	JITO	1	\$184.80	\$184.80
3584471732	AG14	5/11/00	EDO	1	\$58.21	\$58.21
3584472060	AF05	1/14/00	JITO	1	\$163.80	\$163.80
3596000329	AF62	3/15/00	JITO	2	\$99.45	\$198.90
3642062036	AF73	3/29/00	JITO	2	\$104.79	\$209.58
3642062254	AF38	2/15/00	JITO	4	\$48.92	\$195.68
4075711103	AF50	3/1/00	JITO	1	\$65.95	\$65.95
4075771115	AG34	5/25/00	EDO	1	\$57.44	\$57.44

4075771117	AG47	6/9/00	EDO	1	\$57.44	\$57.44
4251484301	AE91	1/6/00	JITO	2	\$2.45	\$4.90
4251484301	AF72	3/28/00	JITO	2	\$2.23	\$4.46
4251484301	AG29	5/22/00	JITO	2	\$2.23	\$4.46
4509001179	AF09	1/21/00	JITO	2	\$104.24	\$208.48
4509001179	AG80	7/20/00	JITO	2	\$104.24	\$208.48
4509001291	AF30	2/4/00	JITO	2	\$111.20	\$222.40
4509001292	AG18	5/11/00	EDO	1	\$444.82	\$444.82
4509001292	AF30	2/4/00	JITO	1	\$111.20	\$111.20
4509009600	AG01	5/1/00	JITO	4	\$126.79	\$507.16
4509015271	AG09	5/9/00	JITO	1	\$93.71	\$93.71
5216452011	AE90	1/3/00	JITO	2	\$32.55	\$65.10
5216489711	AF62	3/15/00	JITO	3	\$18.03	\$54.09
5261221010	AF29	2/18/00	EDO	1	\$35.10	\$35.10
5419011081	AF13	1/24/00	EDO	12	\$51.41	\$616.92
5594008509	AF02	1/13/00	JITO	3	\$51.85	\$155.55
5594008509	AF51	3/2/00	JITO	3	\$51.85	\$155.55
5594008980	AE90	1/3/00	JITO	2	\$66.90	\$133.80
5594008980	AF16	1/26/00	JITO	2	\$66.90	\$133.80
5594008980	AF51	3/2/00	JITO	3	\$66.90	\$200.70
5595000220	AF32	2/7/00	JITO	7	\$60.89	\$426.23
5891060151	AE88	1/3/00	JITO	10	\$24.80	\$248.00
6200912040	AG10	5/9/00	EDO	1	\$61.69	\$61.69
6504004007	AF31	2/6/00	JITO	4	\$31.46	\$125.84
6504004575	AF45	2/24/00	JITO	1	\$198.26	\$198.26
6783052434	AF47	2/24/00	JITO	1	\$185.52	\$185.52
7006281064	AF51	3/2/00	JITO	5	\$4.98	\$24.90
8642052018	AF56	3/8/00	JITO	6	\$22.37	\$134.22
24644360210	AF63	3/15/00	EDO	5	\$52.97	\$264.85
40075771117	AG65	6/23/00	EDO	1	\$57.44	\$57.44
105550070410	AG44	6/5/00	EDO	1	\$403.54	\$403.54
112503984901	AF15	1/25/00	JITO	1	\$95.99	\$95.99
287831142170	AE89	1/3/00	EDO	1	\$111.98	\$111.98
358384810055	AF61	3/13/00	JITO	4	\$112.25	\$449.00
358480045384	AF07	1/14/00	JITO	2	\$52.71	\$105.42
358480045384	AF10	1/23/00	JITO	3	\$52.71	\$158.13
675531001010	AG20	5/12/00	EDO	1	\$117.04	\$117.04
858384430200	AE99	1/11/00	JITO	1	\$85.82	\$85.82
05660000G3	AE87	1/6/00	JITO	2	\$88.84	\$177.68
05660000L2	AE87	1/6/00	JITO	2	\$114.36	\$228.72
05660000L3	AE87	1/6/00	JITO	2	\$114.36	\$228.72
05660000L4	AE87	1/6/00	JITO	3	\$58.10	\$174.30
0566000L24	AE87	1/6/00	JITO	2	\$111.56	\$223.12
0566000L25	AE87	1/6/00	JITO	1	\$124.51	\$124.51
056600CL5M	AF36	2/15/00	EDO	2	\$52.08	\$104.16
056600D186	AE87	1/6/00	JITO	2	\$18.76	\$37.52
056600G122	AE87	1/6/00	JITO	3	\$29.48	\$88.44
056600G181	AE87	1/6/00	JITO	1	\$26.80	\$26.80

056600S304	AE87	1/6/00	JITO	2	\$49.00	\$98.00
05660C092M	AE87	1/6/00	JITO	1	\$121.18	\$121.18
05660CD411	AF36	2/15/00	EDO	2	\$40.48	\$80.96
05660CG903	AE87	1/6/00	JITO	1	\$50.93	\$50.93
05660CG905	AE87	1/6/00	JITO	6	\$39.85	\$239.10
05660CG914	AE87	1/6/00	JITO	4	\$39.81	\$159.24
05660CG915	AE87	1/6/00	JITO	5	\$38.82	\$194.10
05660CG924	AE87	1/6/00	JITO	5	\$26.42	\$132.10
05660CG925	AF36	2/15/00	EDO	7	\$39.80	\$278.60
05660CL869	AE87	1/6/00	JITO	1	\$43.94	\$43.94
05660CL952	AF36	2/15/00	EDO	5	\$43.08	\$215.40
05660G0121	AE87	1/6/00	JITO	1	\$36.76	\$36.76
05660GS62M	AE87	1/6/00	JITO	1	\$62.80	\$62.80
05660GS63M	AE87	1/6/00	JITO	1	\$62.80	\$62.80
05660SG604	AF36	2/15/00	EDO	2	\$35.99	\$71.98
05660SG636	AE87	1/6/00	JITO	2	\$36.27	\$72.54
05660SL613	AE87	1/6/00	JITO	2	\$34.46	\$68.92
05660SL691	AE87	1/6/00	JITO	7	\$40.97	\$286.79
05660SL823	AE87	1/6/00	JITO	1	\$33.70	\$33.70
05660SM690	AF36	2/15/00	EDO	2	\$57.05	\$114.10
05660SM691	AE87	1/6/00	JITO	1	\$46.33	\$46.33
05660SN674	AE87	1/6/00	JITO	1	\$22.97	\$22.97
05660SN764	AE87	1/6/00	JITO	1	\$34.46	\$34.46
05660SP868	AE87	1/6/00	JITO	2	\$45.81	\$91.62
05660SS680	AE87	1/6/00	JITO	1	\$31.66	\$31.66
05660SS683	AE87	1/6/00	JITO	1	\$31.66	\$31.66
05660SS684	AE87	1/6/00	JITO	2	\$26.42	\$52.84
05660UG245	AE87	1/6/00	JITO	2	\$51.31	\$102.62
05660UG255	AE87	1/6/00	JITO	1	\$53.96	\$53.96
05660UG862	AF36	2/15/00	EDO	2	\$36.76	\$73.52
05660UL215	AE87	1/6/00	JITO	2	\$31.78	\$63.56
05660UL245	AE87	1/6/00	JITO	2	\$46.18	\$92.36
05660UL246	AE87	1/6/00	JITO	2	\$46.18	\$92.36
05660UL878	AE87	1/6/00	JITO	3	\$46.18	\$138.54
05660UM214	AE87	1/6/00	JITO	2	\$31.78	\$63.56
05660VB63M	AF36	2/15/00	EDO	1	\$140.56	\$140.56
05660VD832	AF36	2/15/00	EDO	2	\$40.59	\$81.18
05660VP523	AE87	1/6/00	JITO	1	\$102.62	\$102.62
0566SG1643G	AE87	1/6/00	JITO	2	\$35.55	\$71.10
0566SG1644G	AE87	1/6/00	JITO	1	\$36.76	\$36.76
0566SG636G	AE87	1/6/00	JITO	1	\$16.34	\$16.34
0566SL1636	AE87	1/6/00	JITO	2	\$86.15	\$172.30
0566SL1653	AE87	1/6/00	JITO	1	\$89.11	\$89.11
0566SL1690	AE87	1/6/00	JITO	2	\$107.32	\$214.64
0566SM3637	AG34	5/25/00	EDO	3	\$32.20	\$96.60
0566SN1667	AE87	1/6/00	JITO	2	\$97.26	\$194.52
0566SN1669	AE87	1/6/00	JITO	2	\$73.90	\$147.80
0566SP1636	AE87	1/6/00	JITO	1	\$104.16	\$104.16

0566SP6610	AE87	1/6/00	JITO	1	\$19.98	\$19.98
0566VP556M	AE87	1/6/00	JITO	1	\$170.00	\$170.00
05840L7500	AF56	3/8/00	JITO	6	\$5.23	\$31.38
07062C5424	AE96	1/11/00	JITO	1	\$34.72	\$34.72
07062C5628	AE97	1/11/00	EDO	1	\$22.46	\$22.46
070704452A	AG44	6/5/00	EDO	1	\$113.35	\$113.35
070704VAIL	AF27	2/3/00	EDO	1	\$263.25	\$263.25
105660C085M	AE87	1/6/00	JITO	1	\$121.25	\$121.25
2297000B12	AG13	5/11/00	JITO	5	\$277.10	\$1,385.50
229900512B	AG68	6/30/00	JITO	1	\$461.96	\$461.96
22990355L0	AG80	7/20/00	JITO	1	\$326.81	\$326.81
22990PMW35	AF64	3/15/00	JITO	1	\$57.62	\$57.62
22990PMW35	AG09	5/9/00	JITO	1	\$57.72	\$57.72
22990PMW35	AG64	6/23/00	JITO	3	\$57.72	\$173.16
230000662G	AG27	5/18/00	JITO	2	\$14.48	\$28.96
230000697G	AG27	5/18/00	JITO	2	\$36.33	\$72.66
230000698G	AG27	5/18/00	JITO	2	\$36.33	\$72.66
230000PMII	AG33	5/25/00	JITO	1	\$307.19	\$307.19
230008411H	AF34	2/10/00	JITO	1	\$65.25	\$65.25
23000A305H	AG36	5/31/00	JITO	1	\$68.16	\$68.16
23000B121H	AG36	5/31/00	JITO	3	\$51.15	\$153.45
23000J416H	AF34	2/10/00	JITO	1	\$56.54	\$56.54
23000J495H	AF37	2/15/00	JITO	2	\$123.71	\$247.42
23000J958H	AF15	1/25/00	JITO	1	\$60.56	\$60.56
346106822A	AG41	6/2/00	JITO	9	\$28.91	\$260.19
346106828A	AG41	6/2/00	JITO	9	\$33.72	\$303.48
35840L5102	AF44	2/23/00	JITO	4	\$24.63	\$98.52
35840L6100	AF07	1/14/00	JITO	1	\$17.53	\$17.53
35840L6120	AF40	2/17/00	JITO	5	\$13.72	\$68.60
35840L6120	AF44	2/23/00	JITO	4	\$13.72	\$54.88
4352YNJ0512						
9	AF58	3/13/00	EDO	1	\$57.56	\$57.56
4352YNJ0512						
9	AG18	5/11/00	EDO	2	\$57.56	\$115.12
44523400TAN	AF49	3/3/00	EDO	1	\$26.36	\$26.36
450901296F	AF65	3/15/00	EDO	2	\$139.69	\$279.38
450901296F	AF99	5/1/00	EDO	3	\$139.69	\$419.07
450901296F	AF42	2/17/00	JITO	2	\$139.69	\$279.38
450901296F	AG68	6/30/00	JITO	1	\$139.69	\$139.69
450901584S	AG03	5/1/00	EDO	2	\$49.46	\$98.92
450902345N	AF60	3/13/00	JITO	1	\$346.22	\$346.22
45090R1541	AF39	2/15/00	JITO	1	\$142.78	\$142.78
45090R1547	AF59	3/13/00	JITO	3	\$55.66	\$166.98
45090R1549	AF25	2/2/00	EDO	1	\$177.54	\$177.54
45090R1549	AG10	5/9/00	EDO	1	\$177.54	\$177.54
492700G3L2	AF11	1/23/00	JITO	2	\$132.96	\$265.92
492700G4L2	AF11	1/23/00	JITO	4	\$159.55	\$638.20
52470SP058	AF99	5/1/00	EDO	2	\$86.07	\$172.14

52470TC010	AG11	5/9/00	JITO	1	\$54.37	\$54.37
603432B200	AF15	1/25/00	JITO	1	\$47.86	\$47.86
6608E2515H	AG64	6/23/00	JITO	1	\$165.95	\$165.95
			TOTALS	1781	\$29,543	\$68,836

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APPENDIX B: (Q,R) SPREADSHEET RESULTS

ITEM 1:

c_i (\$/unit)	D_i (units/yr)	I_i (days)	θ_i (units)	σ_i (units)	b_i/h_i+b_i (unitless)	Q_i (units)	r_i (units)	F_i (order freq)	S_i (fill rate)	B_i (b/o level)	I_i (inventory invest)
\$0.42	3096	3	25.4	5.0	1.0	314	40	10	1.000	0.000	71.78

ITEM 2:

c_i (\$/unit)	D_i (units/yr)	I_i (days)	θ_i (units)	σ_i (units)	b_i/h_i+b_i (unitless)	Q_i (units)	r_i (units)	F_i (order freq)	S_i (fill rate)	B_i (b/o level)	I_i (inventory invest)
\$6.46	288	3	2.4	1.5	1.0	24	5	12	0.999	0.001	96.47

ITEM 3:

c_i (\$/unit)	D_i (units/yr)	I_i (days)	θ_i (units)	σ_i (units)	b_i/h_i+b_i (unitless)	Q_i (units)	r_i (units)	F_i (order freq)	S_i (fill rate)	B_i (b/o level)	I_i (inventory invest)
\$0.82	912	3	7.5	2.7	1.0	122	15	7	1.000	0.000	55.73

ITEM 4:

c_i (\$/unit)	D_i (units/yr)	I_i (days)	θ_i (units)	σ_i (units)	b_i/h_i+b_i (unitless)	Q_i (units)	r_i (units)	F_i (order freq)	S_i (fill rate)	B_i (b/o level)	I_i (inventory invest)
\$1.13	640	3	5.3	2.3	1.0	87	11	7	1.000	0.000	55.50

ITEM 5:

c_i (\$/unit)	D_i (units/yr)	I_i (days)	θ_i (units)	σ_i (units)	b_i/h_i+b_i (unitless)	Q_i (units)	r_i (units)	F_i (order freq)	S_i (fill rate)	B_i (b/o level)	I_i (inventory invest)
\$5.31	680	3	5.6	2.4	1.0	41	10	16	0.999	0.001	133.16

ITEM 6:

c_i (\$/unit)	D_i (units/yr)	I_i (days)	θ_i (units)	σ_i (units)	b/h_i+b_i (unitless)	Q_i (units)	r_i (units)	F_i (order freq)	S_i (fill rate)	B_i (b/o level)	I_i (inventory invest)
\$5.31	1060	3	8.7	3.0	1.0	52	14	21	0.999	0.001	166.26

ITEM 7:

c_i (\$/unit)	D_i (units/yr)	I_i (days)	θ_i (units)	σ_i (units)	b/h_i+b_i (unitless)	Q_i (units)	r_i (units)	F_i (order freq)	S_i (fill rate)	B_i (b/o level)	I_i (inventory invest)
\$0.11	14000	3	115.1	10.7	1.0	1303	150	11	1.000	0.000	75.44

ITEM 8:

c_i (\$/unit)	D_i (units/yr)	I_i (days)	θ_i (units)	σ_i (units)	b/h_i+b_i (unitless)	Q_i (units)	r_i (units)	F_i (order freq)	S_i (fill rate)	B_i (b/o level)	I_i (inventory invest)
\$0.88	2640	3	21.7	4.7	1.0	200	34	13	1.000	0.000	98.49

ITEM 9:

c_i (\$/unit)	D_i (units/yr)	I_i (days)	θ_i (units)	σ_i (units)	b/h_i+b_i (unitless)	Q_i (units)	r_i (units)	F_i (order freq)	S_i (fill rate)	B_i (b/o level)	I_i (inventory invest)
\$12.48	276	3	2.3	1.5	0.9	17	4	16	0.997	0.002	134.96

ITEM 10:

c_i (\$/unit)	D_i (units/yr)	I_i (days)	θ_i (units)	σ_i (units)	b/h_i+b_i (unitless)	Q_i (units)	r_i (units)	F_i (order freq)	S_i (fill rate)	B_i (b/o level)	I_i (inventory invest)
\$18.07	140	3	1.2	1.1	0.9	10	3	14	0.995	0.002	116.95

APPENDIX C: SIMULATION RESULTS

1. ORDER DAYS PER YEAR: PERIODIC ORDER POLICY (SIM 2)

Statistics:	<u>Value</u>
Trials	500
Mean	46.85
Median	47.00
Mode	50.00
Standard Deviation	3.63
Variance	13.21
Skewness	-0.74
Kurtosis	3.45
Coeff. of Variability	0.08
Range Minimum	35.00
Range Maximum	53.00
Range Width	18.00
Mean Std. Error	0.16

2. PERCENTAGE DECREASE IN ORDER DAYS (SIM1 TO SIM 2)

Statistics:	<u>Value</u>
Trials	500
Mean	57.49%
Median	57.27%
Mode	55.86%
Standard Deviation	3.77%
Variance	0.14%
Skewness	0.26
Kurtosis	3.18
Coeff. of Variability	0.07
Range Minimum	44.79%
Range Maximum	69.03%
Range Width	24.23%
Mean Std. Error	0.17%

3. PERCENTAGE CHANGE IN AHO (SIM1 TO SIM2)

Statistics:

	<u>Value</u>
Trials	500
Mean	9.33%
Median	9.31%
Mode	—
Standard Deviation	3.88%
Variance	0.15%
Skewness	0.70
Kurtosis	5.54
Coeff. of Variability	0.42
Range Minimum	-1.94%
Range Maximum	26.29%
Range Width	28.23%
Mean Std. Error	0.17%

4. TOTAL AHO PERIODIC ORDER POLICY (SIM2)

Statistics:

	<u>Value</u>
Trials	500
Mean	\$560.89
Median	\$560.70
Mode	—
Standard Deviation	\$20.38
Variance	\$415.15
Skewness	2.13
Kurtosis	13.52
Coeff. of Variability	0.04
Range Minimum	\$507.21
Range Maximum	\$673.50
Range Width	\$166.29
Mean Std. Error	\$0.91

5. AVERAGE ON-HAND INVENTORY VALUE (SIM2)

Statistics:	<u>Value</u>
Trials	500
Mean	\$1,010.78
Median	\$1,011.14
Mode	—
Standard Deviation	\$35.20
Variance	\$1,238.74
Skewness	0.19
Kurtosis	3.32
Coeff. of Variability	0.03
Range Minimum	\$910.36
Range Maximum	\$1,124.68
Range Width	\$214.32
Mean Std. Error	\$1.57

6. PERCENTAGE CHANGE IN OHIV (SIM1 TO SIM2)

Statistics:	<u>Value</u>
Trials	500
Mean	7.36%
Median	7.29%
Mode	—
Standard Deviation	3.87%
Variance	0.15%
Skewness	-0.10
Kurtosis	3.11
Coeff. of Variability	0.53
Range Minimum	-5.59%
Range Maximum	19.14%
Range Width	24.73%
Mean Std. Error	0.17%

7. ANNUAL COST OF INVENTORY: PERIODIC ORDER POLICY (SIM2)

Statistics:

	<u>Value</u>
Trials	500
Mean	\$23,650.71
Median	\$23,714.33
Mode	—
Standard Deviation	\$1,344.10
Variance	\$1,806,601.12
Skewness	-0.12
Kurtosis	2.97
Coeff. of Variability	0.06
Range Minimum	\$18,978.33
Range Maximum	\$27,642.80
Range Width	\$8,664.48
Mean Std. Error	\$60.11

8. PERCENTAGE CHANGE IN ANNUAL COST OF INV (SIM1 TO SIM2)

Statistics:

	<u>Value</u>
Trials	500
Mean	-1.59%
Median	-1.49%
Mode	—
Standard Deviation	2.14%
Variance	0.05%
Skewness	-0.19
Kurtosis	2.90
Coeff. of Variability	-1.35
Range Minimum	-8.27%
Range Maximum	3.99%
Range Width	12.26%
Mean Std. Error	0.10%

9. ORDER DAYS PER YEAR, (Q,R) POLICY (SIM1)

Statistics:	<u>Value</u>
Trials	500
Mean	110.40
Median	111.00
Mode	112.00
Standard Deviation	4.73
Variance	22.37
Skewness	-0.36
Kurtosis	3.09
Coeff. of Variability	0.04
Range Minimum	96.00
Range Maximum	124.00
Range Width	28.00
Mean Std. Error	0.21

10. TOTAL AHO, (Q,R) POLICY (SIM1)

Statistics:	<u>Value</u>
Trials	500
Mean	\$507.96
Median	\$508.51
Mode	—
Standard Deviation	\$13.16
Variance	\$173.13
Skewness	0.05
Kurtosis	2.81
Coeff. of Variability	0.03
Range Minimum	\$473.16
Range Maximum	\$544.15
Range Width	\$70.99
Mean Std. Error	\$0.59

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